



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|-------------|----------------------|---------------------|------------------|
| 10/634,274 | 08/05/2003 | Paul A. Farrar | 1303.110US1 | 7065 |
| 21186 | 7590 | 05/02/2006 | EXAMINER | |
| SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A. | | | KEBEDE, BROOK | |
| P.O. BOX 2938 | | | ART UNIT | PAPER NUMBER |
| MINNEAPOLIS, MN 55402 | | | 2823 | |

DATE MAILED: 05/02/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

| | | | | |
|------------------------------|------------------------|--|---------------------|--|
| Office Action Summary | Application No. | | Applicant(s) | |
| | 10/634,274 | | FARRAR, PAUL A. | |
| | Examiner | | Art Unit | |
| | Brook Kebede | | 2823 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 27 March 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-57 and 104-106 is/are pending in the application.
- 4a) Of the above claim(s) 13-57 and 104-106 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-12 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date <u>3/27/06</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on March 27, 2006 has been entered.

Response to Amendment

2. Applicant's amendment filed on March 27, 2006 overcomes the rejections under 35 U.S.C. 112 first and second Paragraph that was set forth in the Office action of December 22, 2005. Accordingly the rejection is withdrawn.
3. The Drawings objection of Office action of March 27, 2006 is withdrawn.

Claim Objections

4. Claims 2, 3, 6, 7, 8, 9 and 11 are objected to because of the following informalities:

Claims 2, 3, 6, 7, 8, 9 and 11 recite the limitation “a first conductive layer,” “a core conductive layer,” “a capping layer,” respectively. It is respectfully suggested that changing “a” to --the-- will provide proper antecedent basis for the aforementioned limitations in the claim. Appropriate correction is required.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

Art Unit: 2823

having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Farr (US/6,376,370) in view of Agnello et al. (US/6,255,217).

Re claim 1, Farrar discloses a method for forming an electronic device comprising: forming a first conductive layer (314) (see Figs. 3C -3E) in an opening (310) in a dielectric structure (308) supported by a substrate (300), the first conductive layer being an adhesion/barrier layer (see Col. 16, lines 12-60); depositing a seed layer (316) on the first conductive layer (314) such that the seed layer (316) and the first conductive layer (314) extend above the dielectric layer (308) (see Fig. 3D) forming a core conductive layer (320 not labeled in Fig. 3G; see Col.) having a top surface (see Fig. 3G) on the first conductive layer (314); and depositing a capping layer (323) (i.e., TaN barrier layer) on the core conductive layer (320), wherein the capping layer (323) is completely covers the core conductive layer (320) (see Fig. 3G) without being on the areas surrounding the dielectric structure (308) (i.e., the capping layer 323 is exclusively formed on top of the core conductive layer 320 and does not have physical contact with dielectric layer 308) (see Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7).

However, Farrar does not disclose subjecting the conductive core layer to a H₂ plasma treatment prior formation of the capping layer.

Agnello et al. disclose method for forming an electronic device comprising depositing of the core conductive layer (20) (i.e., copper layer) into the opening (see Fig. 1) and treating the surface of the core conductive layer with hydrogen plasma (see Col. 2, line 21-56) prior to

Art Unit: 2823

depositing of an inorganic barrier (capping) layer (24) in order to increase surface adhesion of the of the inorganic barrier to the copper conductive layer (see Col. 2, lines 33-56).

Both Farrar and Agnello et al. teachings are directed to method of fabricating copper damascene interconnect devices. Therefore, the teachings of Farrar and Agnello et al. are analogous.

Hence, one of ordinary skill in the art would have been motivated to look to analogous art teaching hydrogen plasma treatment of copper wire layer prior formation of the barrier layer as disclosed by Agnello et al. in order in order to increase surface adhesion between the copper wire and the barrier layer while reducing the native oxide that formed on the copper layer.

Therefore, it would have been obvious to one having ordinary skill in the art at the time of applicant(s) claimed invention was made to provide Farrar reference with teaching hydrogen plasma treatment of copper wire layer prior formation of the barrier layer as taught by Agnello et al. in order to increase surface adhesion between the copper wire and the barrier layer.

Re claim 2, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming a first conductive layer includes forming a layer of refractory metal (381) (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 3, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming a first conductive layer includes forming of a compound of nitrogen and a tantalum alloy, or a compound of nitrogen and a tungsten alloy (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Art Unit: 2823

Re claim 4, as applied to claim 4 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein depositing the seed layer and the capping layer includes depositing the seed layer and the capping layer using low energy ion implantation (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 5, as applied to claim 4 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein depositing the seed layer and the capping layer using low energy ion implantation includes using an implant energy ranging from about 0.1 keV to about 0.8 keV (i.e., within the overlap claimed region of 0.1 keV to 2 keV) (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 6, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming a core conductive layer includes depositing the core conductive layer using a CVD process (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 7, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming a core conductive layer includes forming the core conductive layer at predetermined temperature. Furthermore, the claimed temperature range can be optimized by routine experimentation in order to achieve the desired thickness and surface roughness of the conductive layer (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Art Unit: 2823

One of ordinary skill in the art would have been motivated to optimize the deposition temperature of the conductive layer by using routine experimentation in order to achieve the achieve the claimed temperature range.

Therefore, it would have been to one having ordinary skill in the art at the time of the invention is made to deposit the copper conductive layer at temperature range of room temperature to 250 C, since it has been held where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” See *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955); *In re Hoeschele*, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969); *Merck & Co. Inc. v. Biocraft Laboratories Inc.*, 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), cert. denied, 493 U.S. 975 (1989); *In re Kulling*, 897 F.2d 1147, 14 USPQ2d 1056 (Fed. Cir. 1990); and *In re Geisler*, 116 F.3d 1465, 43 USPQ2d 1362 (Fed. Cir. 1997). Furthermore, the specification contains no disclosure of either the critical nature of the claimed temperature range or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. See *In re Woodruff*, 919, f.2d 1575, 1578, 16 USPQ2d, 1936 (Fed. Cir. 1990).

Re claim 8, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein depositing a capping layer includes depositing one or more materials selected from titanium, zirconium, hafnium, and nitrides of these elements (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Art Unit: 2823

Re claim 9, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein depositing a capping adhesion/barrier layer includes depositing the capping layer having a thickness range of 5 Å to 150 Å (i.e., within the claimed range of ranging from about 5 Å to about 40 Å) (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 10, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein the method further includes removing at least a portion of the dielectric structure, after depositing the capping layer on the core conductive layer, to form an air bridge structure (see Farrar Col.5, lines 7-8) (see also Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 11, as applied to claim 1 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming the first conductive layer, the dielectric structure having multiple dielectrics layers, such that the core conductive layer and the capping layer are within one dielectric layer in the dielectric structure with a top surface of the capping layer substantially level with a top surface of the one dielectric layer (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Re claim 12, as applied to claim 11 above, Farrar and Agnello et al. in combination disclose all the claimed limitations including the limitation wherein forming the first conductive layer in the dielectric structure having multiple dielectric layers includes forming the first

Art Unit: 2823

conductive layer within an opening a polymer layer, a foamed polymer layer, a fluorinated polymer layer, a fluorinated oxide layer, or an aerogel layer (see Farrar Figs. 3A-3K and related text Col. 15, line 18 – Col. 20, line 7 and Agnello et al. Fig. 1; Col. 2, line 21-56).

Response to Arguments

7. Applicant's arguments filed on March 27, 2006 have been fully considered but they are not persuasive.

Applicant argues that “Applicant cannot find the combination of Farrar and Agnello et al. ... a teaching or a suggestion of method including forming a first conductive layer in and opening in dielectric structure supported by a substrate ... ”

In response to applicant's argument, it is respectfully submitted that the combination of Farrar '370 and Agnello et al. '217 disclose all the claimed limitations including the limitation that Applicant contends does not exist as applied in Paragraph 6 above. Furthermore, it is respectfully submitted that the recited claim process and structure can be found in Figs. 3B-3G of Farrar '370 Patent.

Therefore, the *prima facie* case of obviousness has been met and the rejection under 35 U.S.C. § 103 is deemed proper.

Conclusion

8. **THIS ACTION IS MADE NON-FINAL.**

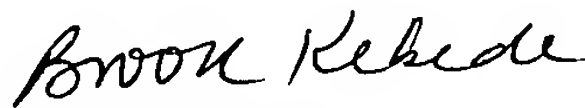
Correspondence

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Brook Kebede whose telephone number is (571) 272-1862. The examiner can normally be reached on 8-5 Monday to Friday.

Art Unit: 2823

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew S. Smith can be reached on (571) 272-1907. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


Brook Kebede
Primary Examiner
Art Unit 2823

BK
April 30, 2006